SOUTH GRAND CHENIER HYDROLOGIC RESTORATION PROJECT (ME-20)

PRELIMINARY 30% ENGINEERING DESIGN REPORT

COASTAL WETLANDS PLANNING, PROTECTION AND RESTORATION ACT (CWPPRA)



U. S. FISH AND WILDLIFE SERVICE LOUISIANA CPRA OFFICE OF COASTAL PROTECTION AND RESTORATION

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PRELIMINARY 30% DESIGN REVIEW REPORT SOUTH GRAND CHENIER HYDROLOGIC RESTORATION PROJECT (ME-20) CAMERON PARISH, LOUISIANA

I. INTRODUCTION:

The South Grand Chenier Hydrologic Restoration project is located south of Grand Chenier, Louisiana, in Cameron Parish, between Louisiana Highway 82 and Hog Bayou in the Hog Bayou Watershed. The major environmental problem in the Hog Bayou Watershed is land loss caused by failed agricultural impoundments and pump-offs. Other problems include saltwater intrusion from the Mermentau Ship Channel construction and a Gulf shoreline erosion rate of 40 feet per year. Over a period of 60 years, 9,230 acres (38% of the original marsh) was lost, with the greatest amount of land loss occurring between 1956 and 1974. The major contributors to land loss in the watershed are subsidence, compaction, and the oxidization of marsh soils in the former pump-offs, and leveed agricultural areas between Hog Bayou and Highway 82. Large areas of marsh south of Highway 82 were "forced drained" during the 1960s, 1970s, and 1980s. Many of these same areas now consist of open water with very little wetland vegetation. The largest area of current loss is in a failed impoundment in the southern part of the project area.

The South Grand Chenier project was approved by the LA Coastal Wetlands Conservation and Restoration Task Force on Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) Priority Project List 11. The United States Fish and Wildlife Service (USFWS) is the Federal sponsor and the Louisiana Office of Coastal Protection and Restoration (OCPR) is the local sponsor. The Department of Agriculture, Natural Resources Conservation Service is responsible for assistance with engineering, design and construction.

The project's goals are to, 1) nourish or enhance emergent marsh with freshwater, nutrients, and some sediment south of Highway 82 via fresher water from the Mermentau River, and 2) restore marsh via dedicated dredging from the Gulf of Mexico.

The conceptual project (Phase 0) consisted of freshwater introduction from the Mermentau River at two locations (BP Plant and the Dr. Miller Canal) to brackish marshes south of Hwy 82 and marsh creation using dredged material from the Gulf. That conceptual plan proposed to restore approximately 400 acres from dredged material placement and nourish or enhance an additional 4,000 acres of emergent marsh through freshwater introduction.

The proposed 30% design is primarily based on the geotechnical investigation/analysis, hydrodynamic modeling report, and historical knowledge of existing similar projects.

II. RECOMMENDED PROJECT FEATURES:

The project features include maintaining the Dr. Miller Canal to flow low salinity Mermentau River water from Upper Mud Lake across Hwy 82 via culverts under that highway. The project also includes the restoration of 452 acres of marsh in two cells via dedicated dredging in the Gulf of Mexico 4 miles south of the project area (Table 1). It is recommended that the existing Dr. Miller Canal freshwater introduction channel have a 40 foot-wide bottom width, 2:1 side slopes, with the bottom elevation at - 3.0 feet NAVD 88 and be fully contained by levees east and west of the channel (Table 1). Corrugated aluminum culverts will be installed at 13 natural drainage areas along the canal to provide drainage from the adjacent marsh to

the freshwater introduction channel. The hydrodynamic modeling report concluded that a Dr. Miller channel bottom elevation of - 3.0 feet NAVD 88 would flow sufficient freshwater southward to reduce salinities in target marshes. The - 3.0 foot elevation was also chosen because the top of the Bridgeline Holdings pipeline crosses that channel at an elevation of - 5.0 feet NAVD 88, and a minimum of 2 feet of cover must be maintained over this pipeline.

Table 1: South Grand Chenier Hydrologic Restoration Project Features.

Channel Improvements

• Widen, deepen, levee, and install 1-way flapgated drainage culverts in the Dr. Miller Canal (20 feet X 4 feet deep; - 3 feet NAVD) and install 4, 42 inch-diameter culverts under the Grand Chenier ridge and Hwy 82.

Structures

- Install/replace a 3 barreled, 48-inch diameter control structure with flapgates at the Dr. Miller Canal and Upper Mud Lake to flow water north and south.
- Install plugs and 2, 48 inch-diameter culverts in the east-west waterway at its intersection with the Dr. Miller Canal and maintenance dredge that canal to its terminus.
- Install levees and 1-way flapgated 36-inch-diameter drainage culverts (at 9 natural drainage areas) on each side of the Dr. Miller Canal.
- Extend the Dr. Miller Canal 50 to 150 feet southeastward to enable culverts to be installed southward without bends in the pipe.
- Install 4, 42-inch diameter culverts with 1-way south flowing flapgates under Grand Chenier and Hwy 82.
- Place culverts or openings in board roads in Area B, and flapgated culverts in the Miller-McCall levee for freshwater flow to Areas B and C south of Hwy 82.

Marsh Restoration

• Restore 170 acres of marsh in southeast Area C and 282 acres of marsh east of Second Lake from Gulf dredged material.

To convey freshwater through the Dr. Miller Canal channel to the marshes south of Hwy 82, one option in the original conceptual plan (Phase 0) was to construct a 1,200 foot-long open channel from the Dr. Miller Canal southward to Hwy 82. The open channel was abandoned due to landowners' objections. To satisfy this objection, 4, 42 inch-diameter 1,200 foot-long culverts were chosen to provide the same volume of freshwater as a channel for this system to function properly. Extending the Dr. Miller Canal up to 150 feet eastward to eliminate the need for a 120 degree angle in the 4 culverts would reducing the long-term maintenance problem of debris collecting in the elbow.

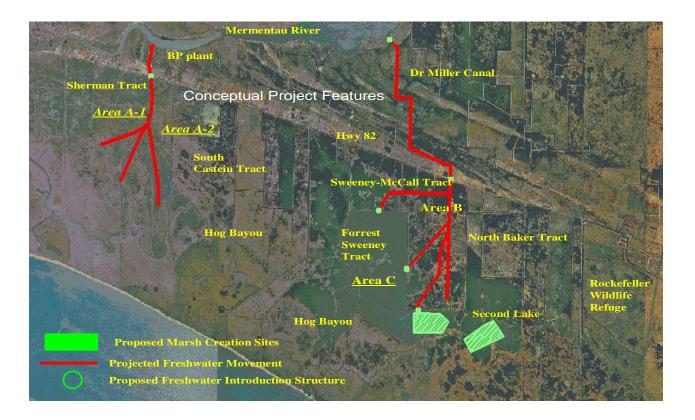
The original conceptual plan, supported by the modeling report, recommended jacking 3, 60 foot-long 48 inch-diameter culverts under Hwy 82. To maintain the required capacity for this system, 4, 1,275 foot-long 42 inch-diameter culverts will be installed under Grand Chenier ridge and Hwy 82. Three culvert design alternatives were considered; 1) a 36 inch-diameter reinforced concrete culvert (\$190 per linear foot), 2) a 42 inch-diameter steel culvert (\$320 per linear foot), and 3) a 42 inch-diameter High Density Polyethylene (HDPE) culvert (\$200 per linear foot).

It is recommended that four, 42 inch-diameter HDPE culverts be utilized to pass freshwater under Hwy 82 to the brackish emergent marshes south of that highway. HDPE pipe was chosen because a solid weld without joints can be obtained that will not deteriorate from exposure to salt water. The State Department of Transportation and Development (DOTD) requires that jacking pipe under a State highway in this part of the State be solid (no jointed pipe) from right-of-way to right-of-way. The HDPE pipe can be fusion welded to eliminate joints. The bottom invert elevation for the 42 inch-diameter HDPE pipe is - 4.0 feet NAVD 88 due to the need to maintain a minimum of one foot clearance between the Tennessee Gas pipeline and the top of the HDPE pipe.

Jacking and boring pipe and open cut pipe installation were methods considered to install the pipes under Hwy 82. A by-pass road would have to be constructed to keep Hwy 82 open to traffic with the open cut construction method. Jacking and boring was selected as the preferred alternative because it is less expensive and less impacting to traffic flow than the open cut method.

It is recommended that approximately 452 acres of marsh be restored in shallow open water by placement of dredged material in two containment areas north and south of Hog Bayou as indicated on the project map (see Figure 1).

Figure 1: South Grand Chenier Hydrologic Restoration Project Conceptual Features.



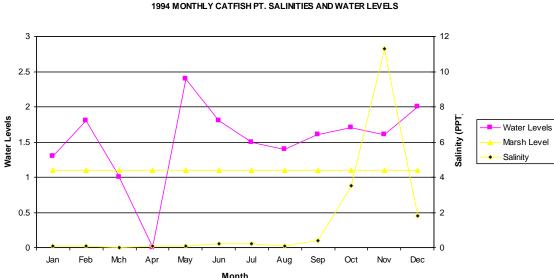
South Grand Chenier Control Structure Operation Schedule

• <u>Freshwater Introduction</u> - Open the Dr. Miller Canal-Upper Mud Lake structure to flow water southward when Mermentau River salinities are less than or equal to 5 parts per

thousand (ppt), rainfall/storm conditions permitted, and water levels are at or below marsh level in marshes adjacent to the channel. (Figure 2 shows that the Mermentau River at the Catfish Point Grand Lake control structure had salinities less than 5 ppt for 11 months in 1994.)

- Freshwater Introduction Stopped Southward freshwater flow at the Upper Mud Lake-Dr. Miller Canal structure would be stopped and flow northward to Upper Mud Lake and southward across Hwy 82 permitted when Mermentau River salinities are greater than 5 ppt, or when the area is threatened with heavy rainfall/storm events.
- <u>Miller Management</u> Structures in Miller-McCall levee bordering Area C south of Hwy 82 will be closed to prevent freshwater inflow during marsh management drawdown events.

Figure 2: 1994 Salinities and Water Levels in the Mermentau River at Catfish Point.



Monitoring and Operation - Structure monitoring and operation will be performed through the State Coastal Protection and Restoration Authority, Office of Coastal Protection and Restoration, if the project is approved for construction. Monitoring for structure operations will consist of continuous salinity and water level recorders placed at the Dr. Miller Canal-Upper Mud Lake intake structures, the Dr. Miller Canal, and continuous water level recorders

placed in the marshes adjacent to Dr. Miller Canal. Data from the monitoring recorders will be transmitted to a common website for access by project managers, the parish engineer, and local drainage district.

<u>Drainage Concerns Addressed</u> - The following project features were designed to reduce drainage concerns for the areas east and west of the Dr. Miller Canal expressed by the Cameron Parish Gravity Drainage District for the Grand Chenier area (Table 2).

Table 2: List of Features that Address Drainage Concerns.

- Project will add 4, 42 inch-diameter culverts at Hwy 82 to provide additional drainage southward across Hwy.
- The levee on each side of canal will prevent Mermentau River water from entering adjacent marshes north of Hwy 82.
- Culverts with 1-way flap gates will maintain normal drainage of areas adjacent to Dr. Miller Canal, but not drain marshes.
- <u>Drainage Northward</u> Drainage northward will also occur, if head differential exists, during storm/heavy rainfall events by closing southward flow at the Dr. Miller Canal and Mermentau River at Upper Mud Lake.
- Modeled Dr. Miller canal water levels were + 1.0 to + 2.0 feet NAVD, or + 0.8 to + 0.5 feet above marsh (marsh level = + 1.2 feet to + 1.5 feet. NAVD)

III. DISCRIPTION OF CHANGE FROM PHASE 0 APPROVAL:

The major feature changes from the approved conceptual project (Phase 0) is the removal of the Area A (BP Plant) freshwater introduction area from the project. According to the Hydrodynamic Modeling Report (Attachment G), the Area A "BP Canal" project component showed no salinity reduction benefits to target area marshes. In some instances, that feature increased area salinities. Therefore it was recommended by the Project Management Team that this project component be eliminated (Table 1, Figure 3).

The conceptual project consisted of installing 24-inch diameter culverts every 500 feet in the Dr. Miller Canal levees (spoil banks) to provide drainage of adjacent marshes and Chenier. The revised project features consist of installing 9, 36 inch-diameter culverts placed in natural drains or low areas to provide adequate drainage. The planned three to four 48 inch-diameter culverts through Grand Chenier ridge and under Hwy 82 were replaced with four 42 inch-diameter culverts due to the need to maintain sufficient cover between the culverts and the highway.

The original conceptual drainage ditch improvement route from the Dr. Miller Canal terminus 4,000 feet eastward to Cannick Pond then southward across Hwy 82 has been removed. Instead, a more direct southerly route has been chosen consisting of extending the Dr. Miller Canal 50 to 150 feet southeastward and installing 4, 42 inch-diameter culverts southward from its terminus across Hwy 82. A Gulf of Mexico borrow area was chosen vs. an Upper Mud Lake borrow because of less distance, less landowners, and not having to cross Hwy 82.

There are no other significant feature changes from the Phase 0 approved project (Table 1).

Figure 3: South Grand Chenier Hydrologic Restoration Project Revised Features.

IV. DESIGN SURVEYS:

The NRCS performed design surveys throughout the project area including the freshwater introduction channel and marsh creation areas (Figure 4). The NRCS surveys were completed using GPS Receivers operating in RTK (Real-Time Kinematic) mode. Horizontal datum was collected on NAD 83, Louisiana State Plane coordinates, south zone (1702) (feet), and vertical datum was NAVD 88 (feet). See the construction drawings for topography, profiles and sections derived from NRCS field surveys (Attachment A).

Figure 4: South Grand Chenier Elevation Survey Locations.



The freshwater introduction channel maintenance and levees and the marsh creation containment dike dimensions and alignments were determined from the survey data. Attachment A contains the description of two monuments used by NRCS for horizontal and vertical control.

Hydrographic and magnetometer surveys were performed on a grid layout that covered the entire Gulf of Mexico borrow area. T. Baker Smith performed the borrow area survey for Burk Kleinpeter, Inc. That survey has been completed and included in this report (Attachment B).

Horizontal positioning was collected on NAD 83 Louisiana State Plane coordinates, south zone (1702) (feet), and vertical positions were adjusted to NAVD 88 (feet). In review of the

pipeline database, one pipeline was located approximately 1,000 feet south of the borrow area. The water depth at the borrow site is approximately 20 feet.

Magnetometer surveys were performed throughout the borrow area by T. Baker Smith for Burk Kleinpeter, Inc. The magnetometer survey is included in the Burk-Kleinpeter, Inc. survey report (Attachment B). This survey showed six possible flow lines and/or other obstructions within the proposed borrow area. Each anomaly was investigated individually and found to be insignificant marine debris. Each possible line was reexamined by gradiometer and visually inspected to make a reasonable professional opinion that the anomalies were not major obstructions or pipelines. However caution should be used when dredging around these anomalies.

V. PRELIMINARY DRAWINGS:

The 30% Preliminary Design drawings are included as Attachment C in this report.

VI. PIPELINE INVESTIGATION:

Three gas distribution pipelines are shown on the preliminary drawings (Attachment C). Two of the pipelines cross the project area roughly parallel to each other on the Grand Chenier ridge and run in an east-west direction. These pipelines are owned by Tennessee Gas Pipeline Company and Gulf South Pipeline Company. The third pipeline is owned by Bridgeline Holdings and crosses the southern portion of the Dr. Miller Canal in an east-west direction. Pipeline information has been provided by each company and has been surveyed by NRCS accompanied by representatives from each pipeline company who assisted in locating their respective pipelines. Preliminary designs have been provided to each company and the company representatives have agreed to the plans. Pipeline Right-of-Way Agreements will be executed with each company in the future.

Additionally, a pipeline owned by Dynegy Pipeline runs roughly in an east/west direction located approximately 1,000 feet south of the Gulf of Mexico borrow area. This pipeline should not affect the project area due to this distance.

VII. GEOTECHNICAL INVESTIGATION AND ANALYSES:

A geotechnical investigation and analysis has been performed by Eustis Engineering (Attachment D). Figures 5 and 6 show the geotechnical boring locations. Additional geotechnical analyses were performed by the Corps of Engineers' Engineer Research Development Center (ERDC) to determine borrow area behavioral characteristics (Attachment E). These analyses will be used to more accurately determine the in situ borrow volume to slurry fill volume and self weight consolidation of the slurry material for the marsh restoration areas.

The parameters for the earthen containment dikes and the dikes along Dr. Miller Canal were determined from the Eustis Engineering and ERDC geotechnical analyses. The foundation properties of the placement areas were evaluated for settlement and the borrow area was evaluated for dredge slurry characteristics. The reports consist of analyses of settlement, parameters for the marsh creation containment dike, pile supports for the corrugated aluminum pipe installation, stable slopes for the freshwater introduction channel and the settlement/consolidation of the marsh creation areas.

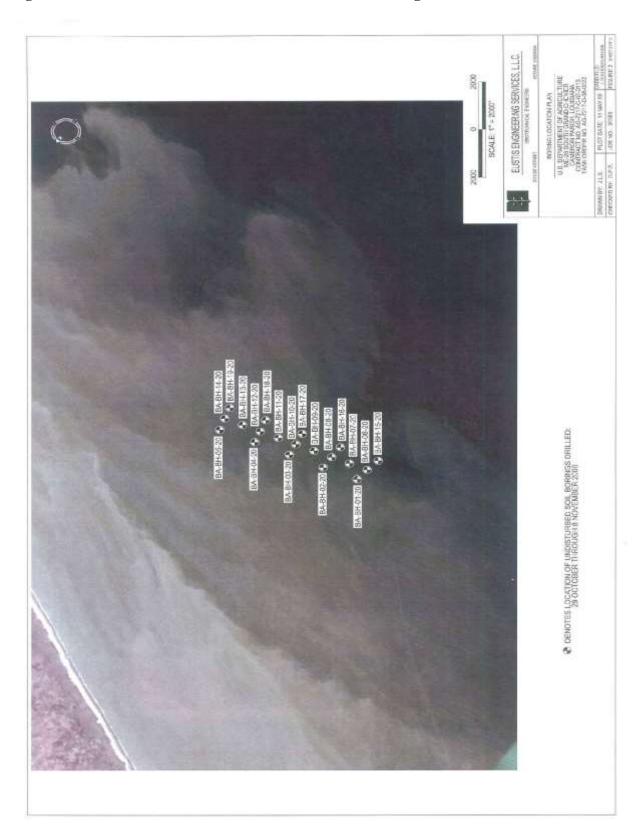
Due to favorable soil properties in the project area, the marsh creation containment dikes will be constructed with in-situ material will have a minimum of + 6.0 foot (NAVD 88) top elevation, a minimum 5 foot top width with side slopes as required. The containment dike

volume will be added to the volume of dredged material needed for marsh creation. The water conveyance channel (Dr. Miller Canal) dikes will have a + 5.0 foot (NAVD 88) top elevation, a minimum 4 foot top width with a minimum 3H:1V side slopes, and 15 feet berm width. The culvert placement in board roads and Miller-McCall levee for water flow to Areas B and C will have a minimum 15 foot top width, a minimum top elevation of + 5.0 feet (NAVD 88), and a minimum 3H:1V side slopes.

Figure 5: South Grand Chenier Project Area Geotechnical Boring Locations



Figure 6: Gulf of Mexico Borrow Area Geotechnical Boring Locations



<u>Corps' Engineering Research Development Center (ERDC) Geotechnical Report</u> Recommendations

The marsh creation areas consist of two units: the east (Second Lake) and the west (Area C). ERDC performed settling analyses for each marsh creation unit using a column settling test to evaluate settlement in each unit. The column settling tests were performed in accordance with Engineering Manuel 1110-2-5027 (USACE 1987). From the test data, the SETTLE model was used to develop settling curves, both turbidity and total suspended solids were measured to develop a flocculent settling curve.

Two 80 foot-deep soil borings were taken by Eustis Engineering and provided to ERDC to perform the column settling test for the 282-acre east unit (Second Lake). The top 6 feet of soil consisted of organic clay, from 6 feet-deep to 30 feet-deep, the material was gray clay (CH), and from 30 feet-deep to 80 feet-deep the soil consisted of clay with shell fragments. A depth of 30 feet was used as the compressible foundation; half of the consolidation was in the upper 4 feet. From the column settling test and target marsh elevation of + 1.3 feet (NAVD 88), it was determined that 707,200 cubic yards of in situ borrow material would be required with a total fill volume of 2,091,499 cubic yards. From the settling curve, the marsh elevation is predicted to be + 0.92 feet NAVD 88 at TY 20 (Attachment E).

Two 80 foot-deep soil borings were taken by Eustis Engineering and provided to ERDC to perform column settling test for the 170-acre west unit (Area C). The top 6 feet of soil consisted of organic clay, from 6 feet-deep to 33 feet-deep, the material was gray clay (CH) and from 33 feet-deep to 80 feet-deep, the soil consisted of clay with shell fragments. A depth of 30 feet was used as the compressible foundation; half of the consolidation was in the upper 4 feet. From the column settling test and target marsh elevation of + 1.3 feet (NAVD 88), it was determined that 355,000 cubic yards of in situ borrow material would be required with a total fill volume of 1,124,491 cubic yards. From the settling curve, the marsh elevation is predicted to be + 0.96 feet NAVD 88 at TY 20 (Attachment E).

This modeling exercise allowed the estimation of dredge material volume and initial dike height at 3-year and 5-year post placement intervals (Tables 3 and 4). In general, the foundation sediment showed low permeability resulting in little consolidation. Analyses of the dredged material displayed slow settling characteristics which would require relative high retention dikes.

VIII. MARSH CREATION DESIGN:

The desired marsh creation target height at 3 years post construction was determined to be + 1.3 feet NAVD 88 by project team members comprised of NRCS, USFWS and OCPR based on NRCS field surveys. Recent project area field surveys established marsh elevations at + 1.2 feet NAVD 88. Fenstermaker and Associates recorded marsh elevations of + 1.5 feet NAVD 88 in their modeling report (Attachment G).

The ERDC marsh creation analyses will be used to more accurately determine the in situ borrow volume to slurry fill volume ratio and self weight consolidation of the slurry fill. The

marsh settlement curves as shown in the geotechnical report were used to establish the marsh creation dredged material fill height.

The initial fill height is established at + 4.5 feet NAVD 88 for the East (Second Lake) marsh creation area, and + 4.3 feet NAVD 88 for the West (Area C) marsh creation area to achieve the desired 3 year marsh elevation as determined in the ERDC marsh creation report (Tables 3 and 4). The containment dike alignment was developed as to fully contain the dredge fill material. We plan to add at least 30% dredged material losses to those quantities estimated in tables 3 and 4, totaling 919,360 cubic yards (707,200 cubic yards + 30%) and 461,500 cubic yards (355,000 cubic yards + 30%) for the East and West areas respectively.

See the preliminary drawings (Attachment C) and geotechnical reports (Attachments D and E) for more detailed information.

Table 3. PSDDF Model Runs – East (Second Lake) Placement Area

	As Placed									Elevation	
	Estimated						Average ²				
	Time to	Predicted				Void	Sediment		Required		
In Situ	Complete	Effluent	Volume	Volume	Volume	Ratio	Thicknes	Fill	Dike ³	At 5	At 3
Volume	Dredging	Conc.1	Sand	Fines	Total	Fines	S	Elevation	Elevation	years	years
yd ³	days	mg/l	yd ³	yd ³	yd ³		ft	ft	ft	ft	ft
700,000	44.2	25.24	8528	2,063,788	2,072,316	9.8748	4.55	4.40	6.40	1.196	1.272
705,000	44.5	25.24	8589	2,077,051	2,085,640	9.8671	4.58	4.43	6.43	1.205	1.281
707,000	44.6	25.24	8614	2,082,353	2,090,966	9.8640	4.60	4.45	6.45	1.208	1.286
707,200	<mark>44.7</mark>	<mark>25.24</mark>	<mark>8616</mark>	<mark>2,082,883</mark>	<mark>2,091,499</mark>	<mark>9.8637</mark>	<mark>4.60</mark>	<mark>4.45</mark>	<mark>6.45</mark>	<mark>1.2088</mark>	1.3022
707,500	44.7	25.24	8620	2,083,678	2,092,298	9.8632	4.60	4.45	6.45	1.209	1.323
708,000	44.7	25.24	8626	2,085,004	2,093,629	9.8624	4.60	4.45	6.45	1.293	1.370
709,000	44.8	25.24	8638	2,087,654	2,096,292	9.8609	4.61	4.46	6.46	1.295	1.372
710,000	44.8	25.24	8650	2,090,304	2,098,954	9.8594	4.61	4.46	6.46	1.297	1.374
725,000	45.8	25.24	8833	2,130,007	2,138,840	9.8367	4.70	4.55	6.55	1.325	1.403
715,000	45.1	25.24	8711	2,103,547	2,112,258	9.8518	4.64	4.49	6.49	1.306	1.384
800,000	50.5	25.24	9747	2,327,329	2,337,076	9.7305	5.14	4.99	6.99	1.464	1.550
820,000	51.8	25.24	9990	2,379,629	2,389,620	9.7041	5.25	5.10	7.10	1.5001	1.5886
825,000	52.1	25.24	10051	2,392,684	2,402,735	9.6976	5.28	5.13	7.13	1.509	1.598
850,000	53.7	25.24	10356	2,457,842	2,468,197	9.6657	5.43	5.28	7.28	1.611	1.703

¹ Assuming a withdrawal depth of 1 ft.

² Average sediment thickness is the average, based on the average existing elevation of -0.15 ft.

³ Assuming 1 ft freeboard and 1 ft ponded depth required.

Table 4. PSDDF Model Runs – West (Area C) Placement Area

	As Placed									Elevation	
	Estimated										
	Time to	Predicted				Void	Sediment		Required		
In Situ	Complete	Effluent	Volume	Volume	Volume	Ratio	Thicknes	Fill	Dike	At 5	At 3
Volume	Dredging:	Conc.1	Sand	Fines	Total	Fines	S	Elevation	Elevation ³	Years	Years
yd ³	days	mg/l	yd ³	yd ³	yd ³		ft	ft	ft	ft	ft
250,000	15.8	42.33	3,046	817,002	820,047	11.0542	2.99	3.14	5.14	0.875	0.920
275,000	17.4	42.33	3,350	890,177	893,527	10.9398	3.26	3.41	5.41	0.905	0.955
290,000	18.3	42.33	3,533	933,760	937,293	10.8766	3.42	3.57	5.57	0.975	1.027
300,000	18.9	42.33	3,655	962,689	966,344	10.8364	3.52	3.67	5.67	1.014	1.068
350,000	22.1	42.33	4,264	1,105,957	1,110,221	10.6553	4.05	4.20	6.20	1.226	1.288
355,000	<mark>22.4</mark>	<mark>42.33</mark>	<mark>4,325</mark>	<mark>1,120,166</mark>	1,124,491	<mark>10.6388</mark>	<mark>4.10</mark>	4.25	<mark>6.25</mark>	1.2402	<mark>1.3038</mark>
360,000	22.7	42.33	4,386	1,134,355	1,138,741	10.6225	4.15	4.30	6.30	1.255	1.319
400,000	25.3	42.33	4,873	1,247,185	1,252,058	10.5007	4.57	4.72	6.72	1.431	1.502
420,000	26.5	42.33	5,117	1,303,170	1,308,287	10.4447	4.77	4.92	6.92	1.490	1.565
423,000	26.7	42.33	5,153	1,311,545	1,316,698	10.4366	4.80	4.95	6.95	1.499	1.575
423,500	26.7	42.33	5,160	1,312,940	1,318,100	10.4352	4.81	4.96	6.96	1.5003	1.5761
424,000	26.8	42.33	5,166	1,314,335	1,319,501	10.4339	4.81	4.96	6.96	1.502	1.578
425,000	26.8	42.33	5,178	1,317,125	1,322,303	10.4312	4.82	4.97	6.97	1.505	1.581

¹ Assuming a withdrawal depth of 1 ft.

IX. BORROW AREA FOR MARSH CREATION FILL MATERIAL:

The marsh creation borrow area is located approximately 4 miles south of the Area C and Second Lake marsh creation areas, in the Gulf of Mexico, south of Grand Chenier, Louisiana.

Borrow Area Wave Refraction Analyses have been completed (Attachment F). Three alternative borrow areas were evaluated in the wave analysis report. Alternative 1 was a 3,000-foot by 3,000-foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. Based on the wave height and direction the impact on the shoreline would be negligible under average conditions. However 1 and 20 year storms are expected to have a significant impact on the sediment transport. Alternative 1 would involve pumping the fill material a greater distance than Alternative 2 which would increase costs.

Alternative 2 is a trapezoidal shaped 6,000-foot by 1,500-foot area located approximately 4 miles south of the marsh creation areas. This borrow area would have a minor impact on the shoreline, but the wave flux would be smaller than Alternative 1. Alternative 2, because it is

² Average sediment thickness is the average, based on the average existing elevation of +0.15 ft.

³ Assuming 1 ft freeboard and 1 ft ponded depth required.

closer to the marsh creation areas, would have reduced pumping costs compared to the other alternatives.

Alternative 3 is rectangular shaped 3,850-foot by 1,500 foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. This borrow site would have the least impact on the shoreline. However to get the required volume of in situ borrow material, an additional 5 feet of cut depth would be required. Alternative 3 would also involve pumping the fill material a greater distance than for Alternative 2, which would increase costs.

Alternative 2 was chosen for the borrow area because its effects on wave height and direction would have a minor impact on the Gulf shoreline south of Grand Chenier. Because the borrow area is one mile closer to the fill areas than the other alternatives, it would have reduced pumping costs. Project benefits would outweigh any borrow site impacts to near shore sediment transport compared to the other sites.

The material required for the two marsh creation areas will be obtained from the borrow site shown on the preliminary drawings (Attachment C). The average depth of cut below the existing Gulf bottom in this area is approximately 15.0 feet which equals to an elevation of -35 feet NAVD 88. The total available in situ volume of material in the borrow area is estimated to be 6,660,000 million cubic yards. The material required for marsh creation is estimated to be 1,380,860 cubic yards (including adding 30%). A safety factor ratio of 4.82:1.0 (6,660,000 CY/1,380,860 CY = 4.82) is generous enough to compensate for any losses that may occur during dredging operations.

See ERDC's geotechnical and modeling reports for further information (Attachment E).

X. HYDRODYNAMIC MODELING REPORT:

Hydrodynamic modeling for this project was completed by Fenstermaker and Associates in December 2005 under LA Department of Natural Resources contract (Attachment G). The modeling report also includes a combined analysis of two hydrologically connected area CWPPRA projects with similar goals and objectives [South Grand Chenier Hydrologic Restoration (ME-20) and Little Pecan Bayou Hydrologic Restoration Projects (ME-17)].

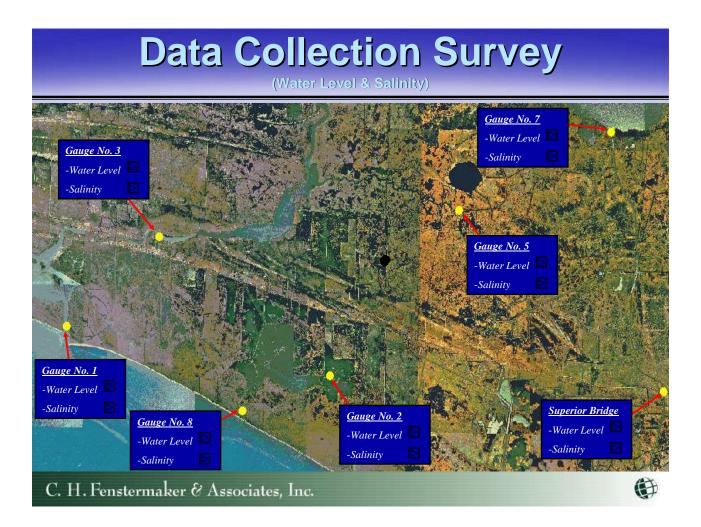
The report's goal was to evaluate the effectiveness of introducing freshwater from the Mermentau River to brackish marshes south of Hwy 82 to reduce salinity levels and lessen salinity spikes. The freshwater introduction feature was also planned to improve marsh productivity, reduce marsh loss, and increase aquatic vegetation within the project area.

A coupled one and two-dimensional (MIKE FLOOD: MIKE 11 and MIKE 21) numerical computer model was set up then initially calibrated and validated for existing project area hydrologic conditions. Direct comparisons of "Base Run" (Existing conditions) and "Conceptual Design Run" (proposed project features) were made including various added scenarios or "runs" (Table 5). The model predicted salinity and water level fluctuations, velocities, and discharges in the project area under various conditions. Salinity transport was computed through an Advection Dispersion (AD) module dynamically coupled with the hydrodynamic model. The continuous recording data collection gage locations are shown in Figure 7. The data used for the model were collected from July 2002 to April 2003.

The report evaluated the performance of the proposed freshwater introduction project features, the Dr. Miller Canal and the BP Canal to convey sufficient freshwater from the Mermentau River to brackish marshes south of Hwy 82 within the South Grand Chenier

Hydrologic Restoration Project area (ME-20). The project features consist of widening and deepening that canal, installing culverts under Grand Chenier and Hwy 82, and placing gaps or culverts in existing board roads and flapgated culverts in the Area C levee south of that highway, to improve freshwater flow southward to target marshes.

Figure 7: South Grand Chenier Modeling Study Water Level and Salinity Gage Locations.

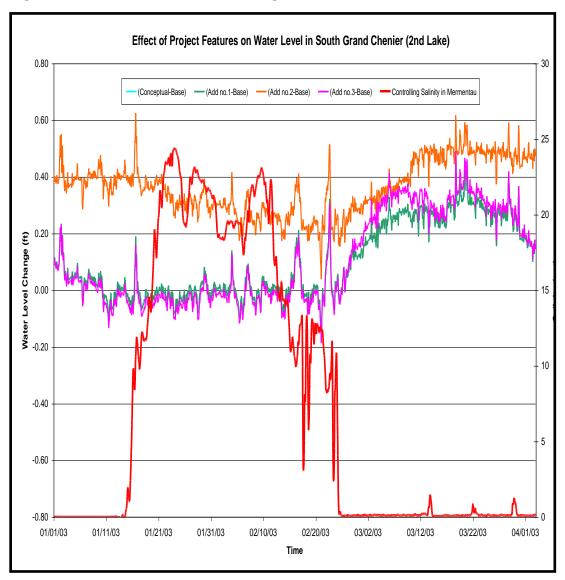


The model runs included, 1) the conceptual project, 2) the addition of a weir at the S-shaped Canal in Area A, 3) 22,000 gallon-per-minute (GPM) pumps at the BP Plant and Dr. Miller Canal and Hwy 82, and 4) increased number of 48 inch-diameter culverts from 2 to 4 under Hwy 82 (Table 5). The model concluded that the Dr. Miller Canal freshwater introduction project component was beneficial in reducing salinities in the target area by an average of 60% [from 5 parts per thousand (ppt) to 2 ppt] (Table 6). The model predicted that the BP Canal freshwater introduction project component would not significantly lower salinities in the target marshes; therefore this component was removed from the project. The BP feature did not reduce salinities south of Hwy 82 because salinities in that part of the lower Mermentau River were almost equal to those in Hog Bayou south of the BP target marshes (Table 6).

Table 5: South Grand Chenier Project Hydrodynamic Model Runs.

- Conceptual Run Conceptual project features included.
- Run No. 1 <u>S-Shaped Canal Weir</u>. Weir with a sill at 1 foot below marsh elevation across the S-shaped canal at Hog Bayou.
- Run No. 2 <u>Model Run with Pumps</u>. Run No. 1 with 48 inch-diameter pumps (approximately 22,000 GPM) at the BP Plant and Dr. Miller canals north of Hwy 82
- Run No. 3 More Hwy 82 Culverts. Increase Hwy 82 structure capacity from 2, 48 inch-diameter to 4, 48 inch-diameter culverts

Figure 8: Predicted Water Level Changes at Second Lake with Various Model Runs.



No. 1 = weir @ S-canal; No. 2 = pumps, No. 3 = 4, 48-inch culverts across Hwy 82.

Table 6: Hydrodynamic Model Results.

- The BP Plant Alternative was not effective in lowering salinities in Area A.
- A weir at the S-shaped canal-Hog Bayou intersection was not beneficial in lowering salinities in Area A.
- Dr. Miller Canal freshwater introduction feature reduced salinities in target marshes an average of 60% (3 ppt) (from 5 ppt to 2 ppt).
- Dr. Miller Canal modeled water levels were + 1.0 to + 2.0 feet NAVD 88 (marsh level = + 1.2 feet to + 1.5 feet NAVD 88)
- Pumps delivered water faster with more control, increased water levels more but overall salinity reduction was equal to gravity drainage structures.
- Increasing the capacity of Hwy 82 structures (from 2 to 4, 48 inch-diameter culverts) reduced salinities slightly more than conceptual run (< 1 ppt; ~ 20%).

Combined Project Conclusions (South Grand Chenier and Little Pecan Bayou)

- Combined project features produced greater salinity reductions beyond original individual project boundaries.
- Running both projects together reduced the head differential and caused less water to flow from north to south especially during highest head periods.

Figure 9: South Grand Chenier Project Modeled Water Level Effects Contour Maps for Various Runs.

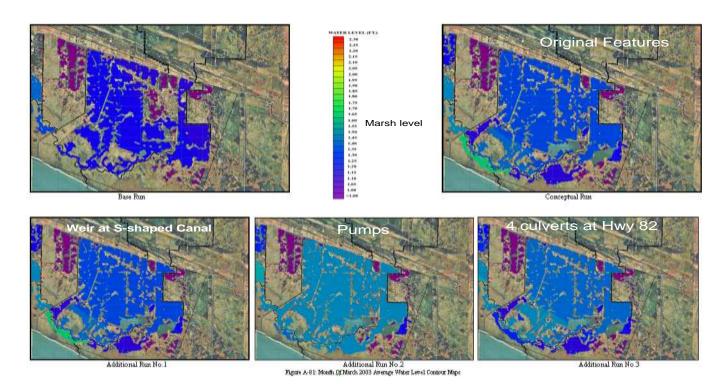


Figure 10: South Grand Chenier Project Modeled Salinity Effects Contour Maps for Various Model Runs.

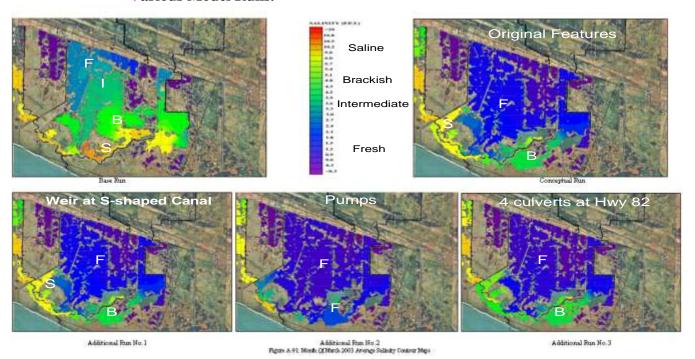


Figure 11: Salinities at Second Lake for Various South Grand Chenier Project Model Runs.

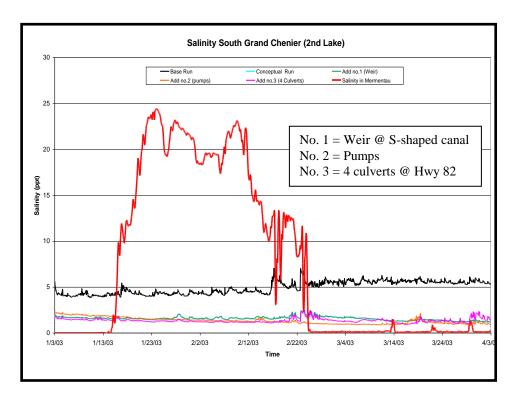


Figure 12: South Grand Chenier Salinity Change Hydrograph at Second Lake for Modeled Runs.

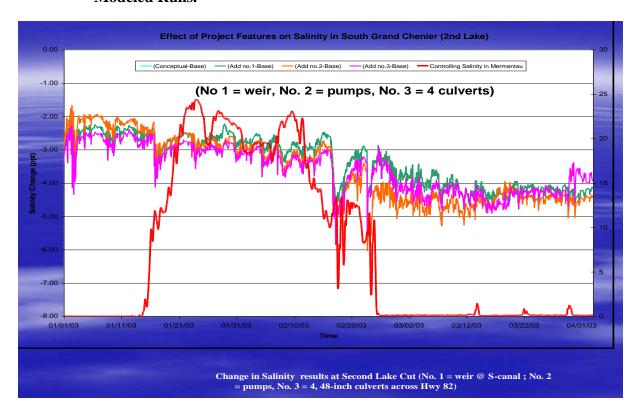
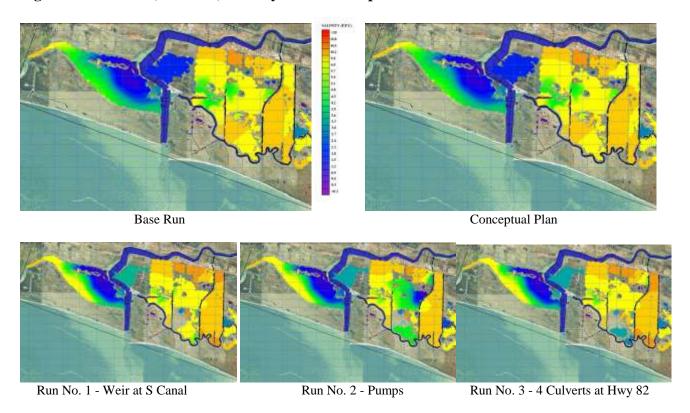


Figure 13: Area A (BP Plant) Salinity Contour Map for March 2003 Modeled Runs.



XI. ANALYSIS OF ALTERNATIVES FOR O&M COST REDUCTIONS:

Three alternative culvert materials were evaluated to convey freshwater from the Mermentau River through the Dr. Miller Canal water conveyance channel to marshes south of Hwy 82. The alternatives consisted of, 1) a 42 inch-diameter High Density Polyethylene (HDPE) culvert, 2) a 36 inch-diameter reinforced concrete culvert, and, 3) a 42 inch-diameter steel culvert. The choice for this project component was the 42 inch-diameter HDPE culvert because this culvert can withstand saline water and low Ph soils without deterioration and has a calculated life span in excess of 100 years. This culvert-type can be fusion welded to achieve a solid length under Hwy 82 which will meet the State DOTD criteria for joint-less (or seamless) culverts under State roadways.

Two alternatives were considered for the drainage pipes emptying into the Dr. Miller Canal and other project feature culverts; aluminum pipe and coated metal pipe. Aluminum material was chosen because the life expectancy in the saline environment is 75 years verses 20 to 25 years for coated metal. Stainless steel hardware will be used to connect pipe components when appropriate.

XII. ECOLOGICAL REVIEW:

Recommendations

Based on the evaluation of available ecological, geological, and engineering information, and a review of scientific literature and similar restoration projects, the proposed strategies of the South Grand Chenier Hydrologic Restoration (ME-20) project will likely achieve the desired ecological goals. Therefore, it is recommended that this project progress towards the 95% Design Review stage pending a favorable 30% Design Review. However, the following recommendations should improve project success:

- The freshwater introduction should be monitored and regulated so as to prevent longduration flooding events of the area marshes.
- Plans should be made to further degrade containment dikes and/or reopen trenasses, if needed, to maintain hydrologic exchange to the created marshes (Lindquist 2009).

See Attachment H for the draft South Grand Chenier Ecological Review report submitted by OCPR.

XIII. LAND OWNERSHIP INVESTIGATION:

The State of Louisiana, through its Coastal Protection and Restoration Authority, Office of Coastal Protection and Restoration (CPRA/OCPR) Lands Section provided a landrights report. That report consisted of colored-ownership tract maps and lists of names, addresses and phone numbers of more than 100 landowners in the South Grand Chenier Project (ME-20) area. Landowner meetings were subsequently held at Rockefeller State Refuge (2003), New Orleans (2003), and the Cameron Prairie National Wildlife Refuge (2006) to present the proposed project features and access routes, and to discuss the hydrodynamic modeling results. The U. S. Fish and Wildlife Service secured letter agreements from all but one of the affected landowners for surveying and geotechnical preliminary field work completed in 2007 and 2008. The OCPR Lands Section obtained a servitude agreement from one undivided landowner for field reconnaissance, surveying, cultural resources and geotechnical investigations (preliminary field work) in the project area.

XIV. OVERGRAZING DETERMINATION

An overgrazing determination was made by the NRCS on July 10, 2008, which determined that grazing did not exist in the project area (Attachment I).

XV. PRELIMINARY CULTURAL RESOURCES ASSESSMENT:

A preliminary cultural resources assessment was performed by the State Department of Culture Recreation and Tourism's Historic Preservation Officer on May 6, 2008. No known archaeological sites or historic properties were noted in the project area (Attachment J).

XVI. OYSTER LEASES:

There are no oyster leases in the project area.

XVII. PRELIMINARY CONSTRUCTION COST ESTIMATE:

The preliminary construction cost estimate with 25% contingency is **\$12,912,187.50**. See Attachment K for a detailed cost estimate.